

Conceptual Design & Options Considered

SD1014 – Desktop Audio System

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Introduction

The Desktop Audio System project is designed to combine multiple audio sources into one single stream, amplify that and provide output to speakers and headphones. The system is to be used in a home or office setting, primarily combined with a desktop computer workstation. The system will combine the strengths of existing audio products and present them in an easy-to-operate package, eliminating the need for more than one audio device (mixer, converter, or amplifier).

Previous Work

iPod Dock

The dock connector allows the iPod to connect to accessories. The iPod Dock makes charging and syncing easier. The dock provides syncing via FireWire or USB 2.0, charging via FireWire and a stereo line out for simple connection to powered speakers or a stereo system.

Behringer UB802 Mixer

This device is a standard 4-channel mixer that takes four analog signals and combines them into one unified output. The device is one of many multi-channel mixers available. This device functions exactly like one portion of the proposed project, however there are many systems that have this mixing functionality.

Ref: <http://www.behringer.com/EN/Products/UB802.aspx>

Stereo Receiver

Most stereo receivers, even if they have more than one input, do not have a mixer and only support amplifying and outputting one input at a time. Also, a typical stereo receiver does not have a USB input to use with a computer as a sound card, or to use for computer control.

Design Options and Selected Approach

For our design, we decided to split the project up into three independent blocks. They are as follows:

- **Input** – Including analog and USB sources, this block will output 4 stereo audio streams
- **Mixer** – This block will take in four stereo audio streams and output a single stream
- **Amplifier** – This block will take in a single stereo stream and output to powered speakers and headphones

For each of these three blocks we have looked at different design methods.

Input Block

The input circuit includes the digital to audio converter.

- 1) Digital to audio converter
- 2) 1/8" stereo jack

Digital to audio converter

It includes The PIC2902E with USB-compliant full-speed protocol controller and S/PDIF. The USB protocol controller works with no software code. Its applications are mainly for audio speakers. It is available easily

PIC LP2951CM which is micro power voltage regulator with very low dropout voltage. Its advantage is error flag output which warns of a low output voltage and the other one is logic-compatible shutdown input which enables the regulator to be switched on and off.

1/8" Stereo Jack

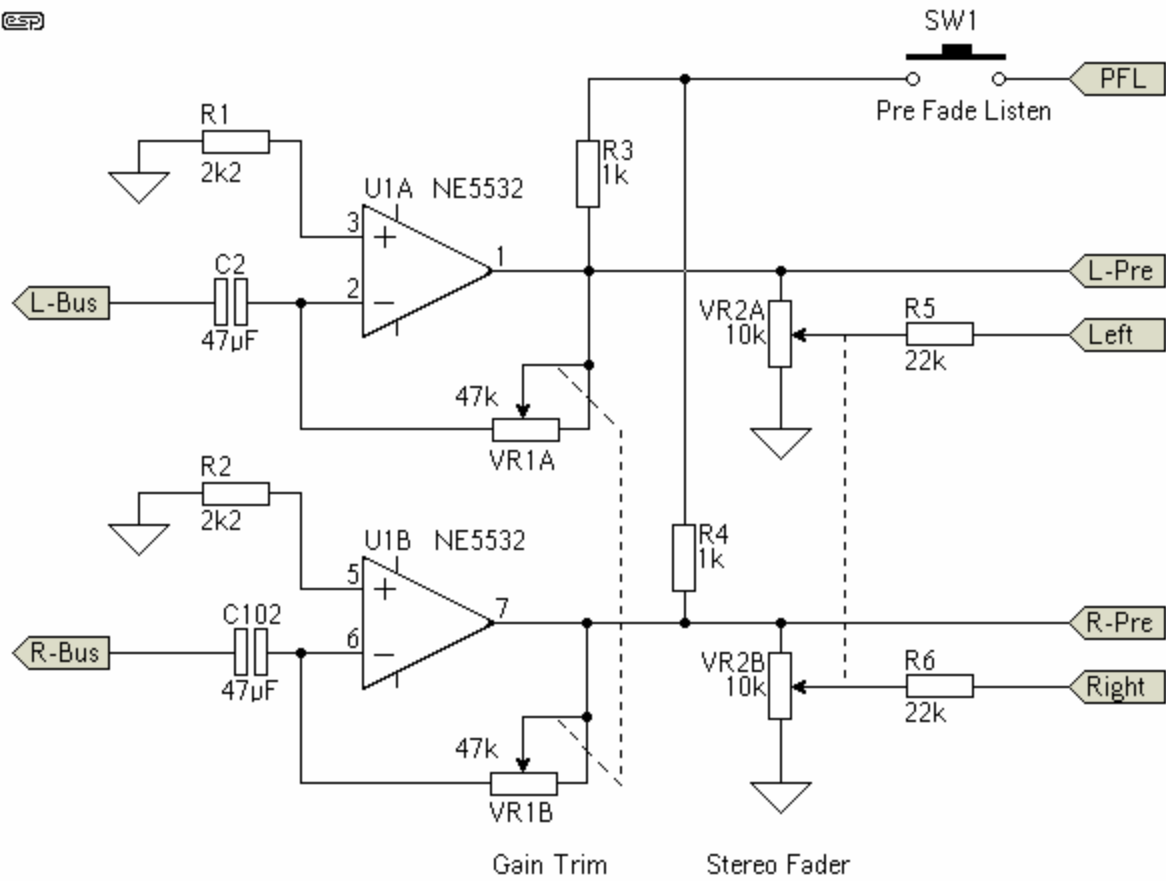
This audio adapter lets you plug lightweight stereo headphones or earbuds into your stereo. Inline adapter accepts a 1/8" stereo plug and fits a 1/4" stereo jack.

- Accepts 1/8" stereo phone plug
- Fits 1/4" stereo phone jack
- You connect lightweight stereo headphones to your home stereo receiver

Mixer Block

This block of our system takes in four (4) analog stereo audio sources and combines them into one unified stereo output. The block will have a user interface that will control the levels of each individual input. The interface will consist of four rotary encoders and an LCD display. Digital potentiometers will do the variation of levels, and be controlled by a microcontroller.

Proposed circuit: <http://sound.westhost.com/project30b.htm>



Microcontrollers

PIC18F4620

Advantages

- Readily available in the department
- Development board available for use already

Disadvantages

- Library would need to be developed for digital potentiometers

Arduino Uno (ATmega328 w/ bootloader)

Advantages

- Native libraries for digital potentiometers and LCDs
- Development board is inexpensive, includes USB power/data transfer
- Simplified Processing-based language (C-like)

Disadvantages

- Not readily available in department

Digital potentiometers

MAX5486 Stereo Volume Control with Pushbutton Interface

Advantages

- LED indicators
- Designed for audio applications
- Stereo

Disadvantages

- TSSOP package – very small and difficult to solder and prototype with
- Pushbutton characteristic would be taken over by the MCU

DS1801 Dual Audio Taper Potentiometer

Advantages

- Can be daisy-chained for use with MCU and multiple chips
- Low power

Disadvantages

- SPI interface may be slow in operation for 4 channels

MCP4531 Dual I2C Digital POT with Non-Volatile Memory

Advantages

- EEPROM allows level-memory on each chip
- I2C interface
- 128 steps

Disadvantages

- Lots of features that may not be used

Selected: Arduino Uno and MCP4531 (or family equivalent)

Amplifier Block

This block will take the output of the mixer and amplify it. The amplifier needs to be able to drive unpowered speakers and also drive a pair of headphones. To simplify the design, the amplifier block will be split into two separate amplifiers, one for the pair of headphones, and one for the unpowered speakers.

For the headphones, the amplifier needs to be able to take a stereo input and provide a stereo output at a level suitable for headphones. Levels will be controlled via digital potentiometers and a rotary encoder.

For the unpowered speakers, the amplifier needs to be able to take a stereo input be able to provide 30 to 40 watts of power to a stereo output. The output needs to be 4 Ohms or 8 Ohms to match most speakers. Levels will be controlled via digital potentiometers and a rotary encoder.

Audio Amplifiers for Unpowered Speakers

National Semiconductor LM4766

Advantages

- 2 Input Channels and 2 Output Channels
- Provides 40 watts per channel into 8 Ohm load
- Overvoltage and Undervoltage Protection
- Thermal Protection
- Mute

Disadvantages

- Requires dual power supply for optimal performance

National Semiconductor LM4765

Advantages

- 2 Input Channels and 2 Output Channels
- Overvoltage and Undervoltage Protection
- Thermal Protection
- Mute and Standby

Disadvantages

- Requires dual power supply for optimal performance
- Only provides 30 watts per channel into 8 Ohm load

Audio Amplifiers for Headphones

MAX13331

Advantages

- Short-circuit protection
- Stereo Input and Output
- Integrated Click and Pop Suppression

Disadvantages

- Surface Mount Chip, so more difficult to solder
- 135mW per channel into 32 Ohm load, so may be lacking in power if headphones with a high impedance are used without a transformer.

LM386

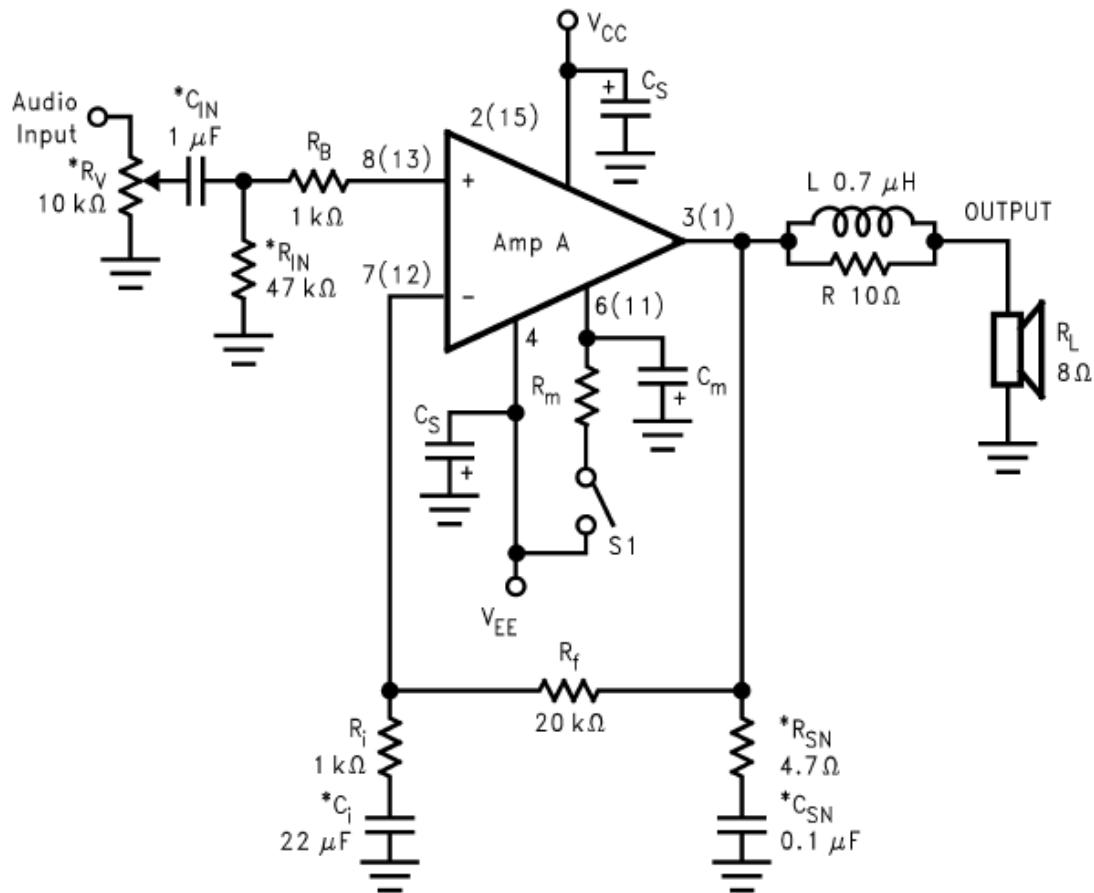
Advantages

- Typical output power of 1W with 16V supply into 32 Ohm load
- Available in 8-DIP package, so easy to work with

Disadvantages

- Has only 1 input, so 2 LM386's required for stereo use

Proposed circuit for speaker amplifier: Auxilliary Amplifier Application Circuit from page 7 of the LM4766 datasheet.



10092807

Proposed circuit for headphones: Dual LM386 amplifiers, one for each channel

Budget

Below is a predicted budget for the project.

Name	Part No	Unit Price	Qty	Total
Digital potentiometer	MCP4531	\$1.20	12	\$14.40
Arduino Uno development board		\$30.00	2	\$60.00
Audio amplifiers (NE5532/MCP602)		\$0.97	12	\$11.64
In-House Circuit Boards		\$0.00	2	\$0.00
IC	PCM2902E	\$5.85	4	\$23.40
IC	LP2951CM	\$0.60	4	\$2.40
Crystal	12MHz	\$1.00	4	\$4.00
	SMD			
Capacitor	Tantal	\$0.32	40	\$12.80
Resistance	SMD 0805	\$0.04	28	\$1.12
LED		\$0.10	20	\$2.00
1/8 sterio jack		\$1.00	6	\$6.00
LCD		\$15.00	1	\$15.00
Rotary Encoders		\$2.00	10	\$20.00
IC	LM4766	\$6.50	3	\$19.50
IC	LM386	\$0.95	6	\$5.70
Passive Components		\$30.00	1	\$30.00
			Total	\$227.96

Timeline

Below is a predicted timeline based on major goals for the project.

Task	Due
Mixer - Build 2-input test circuit (analog pots)	15-Oct
Mixer - Arduino to drive potentiometers	22-Oct
Amplifier - Headphone Amplifier	22-Oct
Mixer - integrate digital pots	29-Oct
Input - amplify any signals to give +/-2.5V	1-Nov
Mixer - Convert test circuit into 4-input	5-Nov
Mixer - Arduino to drive LCD	12-Nov
Amplifier - Speaker Amplifier	12-Nov
Input - USB/Analog conversion	30-Nov
Combine blocks and test	15-Jan
Construct housing	15-Feb
Final testing and addition of components	1-Apr

Summary

This project will be built in blocks. Each block will be independent, providing for a cleaner integration at the completion of the three blocks. Additionally, add-on functionality is possible once the system is fully constructed. It allows for flexibility in each block's design as well.